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How can island communities deal with environmental hazards and hazard drivers, including climate change?

THEMATIC SECTION
Humans and Island Environments

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SUMMARY

This paper provides a critiquing overview of how island communities deal with environmental hazards and hazard drivers, including climate change. The key activity is disaster risk reduction including climate change adaptation, for which many concepts and techniques have emerged from island studies. Although these concepts and techniques are not exclusive to island contexts, this paper focuses on island communities in order to illustrate the importance of human actions in causing and dealing with disasters involving environmental hazards. This point is demonstrated by examining key human and physical geography characteristics representing 'islandness': population, area, geomorphology and connectedness. The characteristics are not mutually exclusive, but island stereotypes emerge as small and static populations, small resource areas, highly volatile and changing geomorphology and limited connectedness. In exploring exceptions and diversities amongst islands, stereotypes are sometimes seen and sometimes not seen in reality. Advantages and disadvantages are demonstrated for different island settings dealing with environmental hazards and hazard drivers.

Keywords: CCA, climate change adaptation, disasters, disaster risk reduction, DRR, environmental hazards, islands, resilience, risk, vulnerability

INTRODUCTION

Island communities are often said to be at the forefront of impacts from disaster risk involving environmental hazards and hazard drivers (UN 1994, 2005, 2014; IPCC 2013–2014). Disaster risk arises from a combination of hazard and vulnerability (e.g. Lewis 1999). Hazards refer to phenomena, events or processes that could potentially harm society. For this paper, the focus is environmental hazards, such as earthquakes and tornadoes, and their drivers (e.g. changes to the climate and human alterations of the landscape). Environmental hazard drivers could have their main origins in nature such as El Niño, could be a combination of natural and anthropogenic causes such as climate change or could be principally anthropogenic such as dams and sea walls.

The process of dealing with disaster risk is termed disaster risk reduction (DRR). DRR focuses on understanding and tackling root causes of disasters to explain why people choose or are forced to live in harm's way. DRR covers all potential hazards and hazard drivers, including earthquakes, volcanoes, droughts, El Niño, floods, storm surges, tsunamis and wildfires.

One major hazard driver is contemporary climate change, which has a significant anthropogenic component due to emissions of greenhouse gases and land use changes reducing the absorption of those gases (IPCC 2013–2014). Sea-level rise is a major expected climate change impact for islands, emerging from three main components (IPCC 2013–2014). First, the increasing mean global atmospheric temperature heats the oceans' surface water. Since water becomes less dense as its temperature rises, this expansion manifests as tens of centimetres of sea-level rise. Second, glaciers and ice sheets are melting, injecting freshwater into the oceans and raising sea levels by centimetres. Third, possibilities exist for large ice sheet collapses, mainly in Antarctica and Greenland, which could raise sea levels by several metres over decades or centuries.

Adjusting to climate change impacts is one DRR subset called climate change adaptation (CCA) (IPCC 2013–2014). Dealing with environmental hazards and drivers amounts to implementing DRR including CCA.

Using DRR including CCA as a baseline, the objective of this paper is to answer the following question: how can island communities deal with environmental hazards and hazard drivers, including climate change? This critiquing overview cannot be comprehensive in covering all of the relevant literature and topics; instead, it extracts key elements from previous work. These key elements move away from the discourse of 'natural disasters' that are 'caused' by environmental hazards and hazard drivers. Instead, the challenge is human actions causing disasters, while the opportunity is human actions dealing with environmental hazards and hazard drivers so that disasters do not occur. This approach is well established in disaster research (e.g. Lewis 1999), but it is less often seen in island studies (one exception is Lewis (2009) who identifies gaps) and is frequently obscured by the dominance of climate change in many sectors.

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To better integrate disaster research with island studies, typical human and physical geography characteristics highlighted as representing 'islandness' (islands, island communities and their characteristics) are explored and critiqued: population, area, geomorphology and connectedness (Royle 1989, 2001; Lewis 1999, 2009; Baldacchino 2007, 2008). The characteristics are not mutually exclusive, such as populations interacting and so incorporating connectedness. For islands, the stereotypical traits are assumed to be small and static populations, small resource areas, highly volatile and changing geomorphology and limited connectedness.

Considering area further, islands are frequently characterized as having small land areas. A balancing dimension is that, for oceanic islands, the water areas that are readily accessible to islanders are often large and thus the ocean can define an island community much more than the land (Hau'ofa 1993). For example, Kiribati has a land area of approximately 810 km^2 and an Exclusive Economic Zone of approximately 3,550,000 km^2. These ratios are not so extreme for less dispersed island jurisdictions, such as in the Caribbean or Mediterranean, or for freshwater islands, such as Manitoulin Island (Ontario) in Lake Huron. Even so, the water plays a significant part in resources and livelihoods, especially for tourism, fishing and mineral extraction. Moves toward electricity generation from renewable sources, including for desalinating water, draw on the surrounding water as much as the land for many island communities.

Regarding geomorphological forms, islands are varied, ranging from low-lying atolls rising just a few metres above sea level, such as Tokelau, to mountains standing over 4 km above sea level, such as Hawai'i. These characteristics help shape the possible environmental hazards as well as responses for dealing with them.

This paper's sub-objectives address the following questions, which are answered in order in the following sections:

- What is a disaster? What do and could island studies offer in dealing with disasters involving environmental hazards and hazard drivers?
- How are the stereotypes of islandness characteristics (population, area, geomorphology and connectedness) representative or not representative for island communities dealing with environmental hazards and hazard drivers?
- What are the general lessons and future directions from and for island communities dealing with environmental hazards and hazard drivers?

ISLAND COMMUNITIES AND DISASTERS

This section provides an overview of the theoretical baseline, linked to practice, for island communities dealing with environmental hazards and hazard drivers, including climate change. The island emphasis does not denigrate non-island contributions or wider scopes. It highlights the contributions from island-related literature, as per the mandate of this thematic issue and the papers in it.

What is a disaster?

Hazards and vulnerabilities combine to form disasters (UNISDR 2009). Many environmental phenomena are simultaneously hazards and resources for society, supporting livelihoods and making living in a place viable. For instance, volcanic slopes and river floodplains are frequently productive agricultural lands, encouraging settlement. Whilst no location could be free from all environmental hazards, the smaller the land area, the more difficult it is to find settlement locations far from the most devastating environmental hazards, identifying a challenge faced by many islanders. All of Sicily (Italy) is in range of Mount Etna's volcanic ash. All of Tongatapu (Tonga) would be severely shaken by a nearby subduction zone earthquake, with all of the main settled areas in the potential tsunami inundation zone.

Rather than hazards causing disasters, instead social and political processes, circumstances and characteristics lead societal groups to be potentially harmed by hazards (vulnerability) or to be able to deal with those hazards (resilience) without being harmed (Lewis 1999; UNISDR 2009; IPCC 2013–2014). Examples are (in)equity, (in)justice, lack/presence of livelihoods and lack/presence of access to resources. Vulnerability and resilience are not strictly opposites, because both can exist simultaneously due to the same social process (Box 1).

> Box 1 Simultaneous vulnerability and resilience due to tourism in Maldives.
> Tourist resorts in Maldives provide livelihoods and income, giving people resources and choices, thereby increasing their resilience, while also making them dependent on the global economy (e.g. currency exchange rates), thereby increasing their vulnerability. The greenhouse gas emissions from tourists' travel contribute to climate change-induced sea-level rise, which is likely to exacerbate flooding and erosion of Maldivian islands. Separating many tourist resort islands from Maldivian communities restricts Maldivian livelihood and living options, thereby increasing vulnerability. It also helps to preserve Maldivian culture and identity, supporting community coherence for resilience, yet maintaining inequitable and oppressive cultural traditions, leading to vulnerability.

Despite this paper referring to 'island communities', DRR including CCA accepts that communities are not homogenous, but have various groupings, sectors, power structures and differences within themselves (Lewis 1999). One consequence is that one community group might reduce vulnerability for some while (or through) increasing vulnerability for

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others. Different community groups could also work at cross-purposes in enacting DRR including CCA.

Because social and political processes occur over multiple time and space scales, the groups within society creating and perpetuating vulnerability and resilience to environmental hazards and hazard drivers are not always those experiencing any disasters. For instance, international trade regimes incentivizing livelihoods dependent on external forces, such as tourism, alongside decisions by insurers in world financial capitals to increase disaster premiums, affect Barbados's vulnerability and resilience to environmental hazards and hazard drivers, despite Barbados having minimal influence on these decisions (Pelling & Uitto 2001).

Given that vulnerability is a necessary input into a disaster, alongside hazard, and given that vulnerability is entirely an anthropogenic process (constructed socially and politically), few 'natural disasters' exist, because most disasters are human-caused through vulnerability. In fact, most disasters could be averted through long-term vulnerability reduction and resilience building. Many hazards are also influenced by human activities, such as wildfire regimes affected by forest management and flood regimes affected by river and coastal engineering, making those hazards not quite natural (e.g. Tobin (1995) for floods and Johnson *et al.* (1998) for wildfires). Some environmental hazards, however, can have planetary-wide consequences irrespective of DRR, such as ice ages and large-magnitude volcanic eruptions.

Within these varied human and environmental influences on hazards, contemporary climate change is one global hazard influencer with a significant proportion that is caused by human activities and yielding considerable concerns for island communities (IPCC 2013–2014). Climate change primarily affects weather-related hazards, changing the frequencies, intensities and extents of potential hazards such as storms, precipitation-related floods and droughts, and landslides (IPCC 2013–2014). Warming and rising oceans further affect ecosystems, including through coral bleaching and salinification of coastal lowlands (IPCC 2013–2014). The changing environment can lead to increased numbers of invasive species and can contaminate freshwater supplies with saltwater, and cannot always be addressed through traditional, local knowledge (e.g. Nunn 2009).

Climate change effects are particularly acute for island communities, from the small island developing states (SIDS) to the Arctic (IPCC 2013–2014). The emerging patterns of island vulnerability and resilience are complex. As will be further explored below, much depends on how resources are allocated and managed, cementing the human cause of disasters.

What do and could island studies offer in dealing with disasters?

Islands have long contributed significant knowledge to dealing with environmental hazards and hazard drivers, including climate change. These contributions provided many foundational theoretical and empirical works for dealing with environmental hazards and hazard drivers, including climate change. Many disciplines have contributed in this area, including anthropology (Belshaw 1951), human and physical geography (McLean *et al.* 1977), seismology (Angenheister 1921) and development studies (Lewis 1981). The 1970s yielded seminal literature alongside the beginning of concerns about climate change and the founding of contemporary theories of vulnerability and resilience to environmental hazards and hazard drivers. Two island-related projects stand out from this decade (Boxes 2 and 3).

Box 2 The Bradford Disaster Research Unit (BDRU).
The BDRU ran from 1973 to 1977 at the Project Planning Centre, University of Bradford, UK. Their work focused on islands (e.g. Gane (1975) for the Pacific and O'Keefe and Conway (1977) for the Caribbean) in order to extrapolate understanding regarding disasters and vulnerability to more general contexts. BDRU's research approach was deliberately non-disciplinary, drawing on a variety of theories, methods and evidence in order to explore why disasters occur and how they might be prevented. A foundation was provided for explaining why disasters are not isolated, extreme, unexpected events caused by hazards, but rather occur due to chronic, deep-rooted circumstances of development caused by social and political conditions, as is starkly evident from the island case studies they examined.

Box 3 UNESCO/UNFPA Population and Environmental Project in Fiji.
This project was organized from 1974 to 1976 under the auspices of the Man and the Biosphere Programme. Brookfield *et al.* (2012) explain that it was a pilot project seeking to apply research on human–environment interactions, especially regarding environmental conservation and natural resource management. Sustainable development concepts were just beginning to engrain themselves in policy, and this ethos was investigated within the project. Islands were selected because the researchers felt that smallness and isolation were best suited for exploring the project's themes.

The themes from Boxes 2 and 3 continued through the ensuing decades of research, policy and practice related to island communities dealing with environmental hazards and hazard drivers. By using Antigua, Lewis (1984) designed a methodology of constructing a multi-hazard history, breaking down the silos separating hazards by discipline. Using Tuvalu and sea-level rise, Lewis's (1989) work became one of the first peer-reviewed journal papers to connect vulnerability theory and climate change.

Through the Malé Declaration on Global Warming and Sea Level Rise (1989), the Alliance of Small Island States (AOSIS) was founded to lobby for SIDS' interests in international climate change negotiations. AOSIS has become a powerful group within UN contexts (UN 1994, 2005, 2014), highlighting small countries' vulnerabilities to external forces and keeping ocean topics prominent in UN agendas (Betzold 2010; Betzold *et al.* 2012). The 2015 climate change negotiations in Paris leading to the UNFCCC (2015) agreement demonstrated not only AOSIS's influence in the intense discussions surrounding a global mean temperature target of 1.5 °C above pre-industrial levels, but also their ultimate lack of power through their failure to set the agreement's baseline below 2 °C (Fry 2016). SIDS have been less prominent in international DRR negotiations, not because of a lack of interest, but because of a lack of resources and of bargaining power. Their interests nonetheless end up being expressed in voluntary international agreements on DRR (e.g. UNISDR 2015), mainly via mentions of islands as being particularly vulnerable.

With the founding of island studies followed by expanding research into the particular vulnerabilities and resiliences of islands (Journal of Coastal Research 1997; Sustainable Development 2006), island communities have continued to be leaders in developing and testing innovative methods for DRR including CCA. Examples are:

- Combining different knowledge forms to ensure that neither local, traditional knowledge nor external, scientific knowledge is side-lined in DRR including CCA (Nunn 2009).
- Community members using local materials to build three-dimensional desktop maps for identifying their hazards, vulnerabilities and resiliences (Maceda *et al.* 2009; Leon *et al.* 2015).
- Historical reconstructions to intuit islander decision-making regarding, and influences on, local environmental changes (Nunn 2003).

All of these examples indicate the balance of internal and external factors contributing to hazards, hazard drivers, vulnerabilities and resiliences, exemplified by island communities and their characteristics.

HOW ARE ISLAND STEREOTYPES REPRESENTATIVE OR NOT FOR DISASTER RISK REDUCTION?

Population

Islands are generally assumed to have small communities with strong kinship networks. This characterization has plenty of truth, especially for more remote locations, along with plenty of exceptions, notably for cities comprising islands and cities on islands such as Copenhagen, Jakarta, Manila, Mumbai and New York (Grydehøj 2015). For dealing with environmental hazards and hazard drivers, no specific population characteristic is inevitably a panacea or a detriment; population characteristics have both advantages and disadvantages.

A smaller population has fewer total requirements for dealing with environmental hazards and hazard drivers, but also might lack the skills or resources to deal with them internally. Consequently, islands frequently pool resources through organizations (such as AOSIS) in order to harness the best expertise from across island communities while providing a focal point for island interests and advocacy/action power, which might otherwise be diluted. Countries such as the Faroe Islands and St Kitts/Nevis, with populations of approximately 50,000 each, would have trouble finding in-country individuals with the deep technical expertise across all scales and activities needed for dealing with environmental hazards and hazard drivers.

Multilateral cooperation overcomes limited population size by bringing together experts from around a region to support all countries within that region on a specific topic, such as the UNFCCC (2015) and the UNISDR (2015) agreements. Pooling resources is further advantageous in drawing on multiple, diverse perspectives rather than producing a cloistered, inward-looking framing, which could overlook lessons and advice from others' experiences and perspectives.

Small populations, especially with stronger kinship-based connections, display nimbleness and swiftness in preparing for and responding to environmental hazards due to trust and ease of communication. Impediments are seen through petty disputes and loss of trust precisely due to tightness, smallness and familiarity. While the island literature examines such issues of kinship and trust (e.g. Randall *et al.* 2014), there is little empirical research examining a population's kinship, internal trust and coherence for dealing with environmental hazards and hazard drivers.

Furthermore, a small population does not necessarily mean an ignorant population. Island communities often have extensive knowledge about their local environmental hazards and hazard drivers and are sometimes able to respond well through local warning systems (examples are given in the next section). Nevertheless, no knowledge system could ever be complete. External knowledge should contribute, provided that it supplements and complements, rather than displaces or supersedes, local knowledge – and vice versa. Local knowledge should neither dominate nor disparage external knowledge.

Island communities have led research and application regarding combining knowledge systems for dealing with environmental hazards and hazard drivers. Cronin *et al.* (2004a, 2004b) brought together community members, government representatives and external scientists in order to deal with volcanic hazards in Vanuatu and Solomon Islands. Facilitated by external parties, an open, participatory process for applying everyone's knowledge, for identifying gaps and for filling in the gaps overcame distrust and political conflict.

Gaillard and Maceda (2009) adopted a multi-hazard, multi-vulnerability, multi-resilience approach for Filipino communities, piloting participatory 3D mapping (P3DM). Minority and majority community members joined with local government, local and external scientists and non-governmental organization workers to build scale models of the community using locally sourced materials in order to identify hazards, vulnerabilities and resiliences. P3DM combines knowledge forms from different societal groups, yielding original data for risk analysis while leaving behind a legacy of the map and increased awareness. This knowledge and the map's data can be shared externally in order to maintain dialogue and to continue seeking external collaboration for action. Leon *et al.* (2015) used this method for BoeBoe village (Solomon Islands) with similar success, focusing on the hazard driver of climate change, especially with regards to sea-level rise.

A population's dispersiveness can be advantageous in dealing with environmental hazards and hazard drivers when island diasporas mobilize to assist their affected home. Island communities receive remittances for post-disaster assistance, with kinship networks meaning that remittances usually exceed official aid in terms of effectiveness, speed and reaching the most affected people (Le De *et al.* 2015). Islanders have long used economic migration and remittances as risk management and livelihood strategies (Bertram & Watters 1985). Migrants reduce an island community's population, thus taxing local resources less, while developing their own, external resources to assist their home communities.

Island communities have also been prominent regarding discussions of forced migration as a response to environmental hazards and hazard drivers. Islanders have long undergone forced migration with no guarantee of return due to environmental hazards including volcanic eruptions (e.g. Niuafo'ou (Tonga) in 1946) (Lewis 1979) and hazard drivers including climate and sea-level changes (e.g. around the Pacific in the fourteenth century) (Nunn 2007).

In contemporary work, the most notable manifestation is the rhetoric on islanders becoming 'climate refugees' due to the hazard driver of climate change. Some island communities are planning and undertaking relocation due to only climate change, such as from the Carteret Islands (Papua New Guinea) (Yamamoto & Esteban 2014; Connell 2016) and from Kivalina and Shishmaref (Alaska) (Bronen & Chapman III 2013). Some entire island countries are considering migration due to climate change, such as Kiribati and Maldives. Even though they consider this migration to be forced, the islanders tend to reject the label of 'refugees' because they wish to control the manner, mode and timing of their movement as much as is feasible, even while recognizing the need for external assistance in effecting their own migration-related decisions (McNamara & Gibson 2009).

The discussions regarding islander migration for dealing with environmental hazards and hazard drivers occurs within the context of many islanders having long been migrants (Hau'ofa 1993). Pacific exploration over the last few millennia and the extensive Caribbean communities in North America and Europe evidence reasons for migration being livelihood, education, family, health and adventure/exploration. These reasons do not justify forced migration due to contemporary human-induced environmental changes. They do indicate that stereotypical assumptions regarding island populations have truths and exceptions, with the populations' characteristics providing advantages and disadvantages in dealing with environmental hazards and hazard drivers.

Area

As noted in the introductory section, islands are frequently characterized as having small land areas, but their water areas play important roles. Even islands that are comparatively large in land area frequently look towards their water. Greenland is one of the largest islands in the world by land area. It is mainly covered by an ice sheet, so communities remain coastal, small and dispersed – half of Greenland's population lives in settlements of fewer than 3000 people – while using comparatively little land area for living and livelihoods. Instead, traditional livelihoods are based on ocean hunting and fishing, while more recent livelihoods, such as administration, tourism and small businesses, are based within the settlements (Statistics Greenland 2016).

Despite the contribution of water area to island life and livelihoods, few islanders live on or in the water. Some nomadic peoples live in boats, such as throughout the Mergui Archipelago (Burma) (Dancause *et al.* 2009). Consequently, most islander homes sit on the limited island land area, and dealing with environmental hazards and hazard drivers generally occurs in this same area, including when evacuating elsewhere. For locations without higher ground or without much land to evacuate to, such as atolls, with enough warning, tsunamis can be ridden out by travelling to the deep sea.

The generally small land areas of islands thus impose significant constraints on dealing with environmental hazards and hazard drivers. Tsunamis can inundate 100% of such land area, salinating freshwater supplies and agricultural land for years, as occurred for some Maldivian atolls on 26 December 2004 (Orłowska 2015). The eruption of Laki, Iceland, from 1783 to 1784 led to a famine killing approximately 25% of Iceland's population (Grattan & Charman 1994). Ireland's population required more than a century to recover to the levels seen prior to the main nineteenth century famine and emigration period (Boyle & Grada 1986). Many volcanic eruptions have led to entire island evacuations, such as Niuafo'ou (Tonga) (Lewis 1979) and Vestmannaeyjar (Iceland) (Chester 1993). An environmental change or trend can make living on an island unviable, as occurred for Pacific communities in the fourteenth century (Nunn 2007). Such difficulties were also seen during droughts in the twenty-first century affecting Tuvaluan islands, for which continued habitation might not have been feasible without importing water and desalination equipment (Kuleshov *et al.* 2014).

Nevertheless, islanders have had many successes in dealing with environmental hazards within the small land areas of their communities (Box 4). In the western Pacific, many islands have been continuously occupied for over three millennia (Hung *et al.* 2011). Inhabitants of Simeulue (Indonesia) have oral traditions of tsunami warning and response, so they evacuated to high ground after feeling an earthquake on 26 December 2004, saving their lives during the subsequent tsunami (Gaillard *et al.* 2008). In all of these cases, despite the small land areas of the islands, sufficient locations existed that enabled the population to move out of harm's way for the particular environmental hazards experienced.

Box 4 Island knowledge for surviving a cyclone.
On 28 December 2002, Tikopia and Anuta in the far east of the Solomon Islands experienced Category 5 Cyclone Zoë, which wrecked most of the community infrastructure. No immediate fatalities occurred because the population, despite having no off-island communication at the time, knew the signs of a forthcoming cyclone and prepared themselves by stockpiling food, protecting fishing equipment and retreating upslope in order to shelter under overhanging rocks (Treadaway 2007). They had dealt with the immediate threat to life themselves. They did need external aid for reconstruction, which was delayed because no off-island communication was available and because the government of the Solomon Islands, being embroiled in political disputes, did not send out reconnaissance. A journalist eventually chartered a helicopter and landed in the area, before then selling an exclusive story that the islanders had survived but needed assistance.

Geomorphology

Observations of island geomorphological responses to changing sea levels are mixed at present (Woodroffe 2008; Rankey 2011; Kench *et al.* 2015; Albert *et al.* 2016; Nunn *et al.* 2016). Depending on localized parameters such as waves, currents and human activities including sea walls and sand mining, islands have grown, shrunk, changed longitudinally or not been significantly affected in locations with measurable sea-level rise. Future responses, as sea levels increase and perhaps the rate of rise accelerates, are hard to project, except to note that island disappearance is a possible but not inevitable outcome.

Another uncertainty is ocean acidification. Ocean water absorbs some of the increased atmospheric carbon dioxide, yielding carbonic acid, which increases oceans' acidity. The impacts of acidification on coastlines including shingle beaches are not well understood. Coral reefs experience the two-fold stress of increased acidity and increased temperatures, which can kill them through coral bleaching. While coral reefs across previous millennia rebounded from massive bleaching events as well as large changes in sea level and ocean temperature, it is unclear how well they will survive under contemporary climate change projections (Hoegh-Guldberg 2014). Coral reefs protect land from currents and waves, meaning that massive coral die-offs could expose island shorelines to the ocean's full power, leading to accelerated geomorphological changes (Hoegh-Guldberg *et al.* 2007).

Even if geomorphological changes do not destroy islands, dealing with some environmental hazards seems likely to become more difficult under climate change. Freshwater management will become challenging as rising seas salinate groundwater and freshwater lenses. As ecosystems change, subsistence food will be affected due to invasive species and species extinctions (Wetzel *et al.* 2012; Betzold 2015). The potential impacts on fisheries are particularly concerning due to many island communities' reliance on this sector (Nurse 2011). Changing biota, in turn, affects island geomorphology (e.g. if coastal vegetation no longer traps sediment or if inland vegetation no longer anchors soil during rainfall).

Human responses that alter an island's geomorphology, such as raising islands above the sea or building floating settlements, have been proposed (Yamamoto & Esteban 2014). While the engineering appears to be technically feasible, the funds required are so far not available. Consequently, much discussion has emerged regarding migrating from island communities as a method of dealing with environmental hazards, or forced migration as a failure to deal with environmental hazards, including both climate-related and volcano-related hazards (see above).

Many islands are volcanoes, and this fact shapes livelihoods, due to, for example, the fertile soil resulting from volcanic ash or the lack of arable land due to hardened lava. There can be long periods between a volcano's eruptions, so the current human population that is settled on an island might have limited knowledge of a volcano's potential activity, as occurred for Montserrat in the Caribbean in 1995 (Pattullo 2000). Lack of knowledge and experience can inhibit responses to environmental hazards, underscoring the importance of combining local and external knowledge forms (see above). The town of Sete Cidades, Azores, sits in a caldera with volcanic walls rising over 150 m above the settlement. One potentially apocryphal story from the town, as told to this author during field work there, is that, prior to modern transportation, people could be born in the town and never leave the caldera; they would never have seen the sea despite being just a few kilometres from the coastline. The island's geomorphology precluded experience with the ocean and associated environmental hazards.

Connectedness

The stereotype of islands as isolated, insular and marginalized, which then creates difficulties for dealing with environmental hazards and hazard drivers, appears often (e.g. Boxes 3 and 4). A lack of connectedness can, however, also lead to striving for self-sufficiency, thereby enabling islanders to deal with environmental hazards and hazard drivers (Box 5).

Box 5 Disaster risk reduction on an isolated island: Cuba. Cuba is a large island that is not geographically isolated, although it was politically isolated by its neighbour the USA soon after Fidel Castro took power in 1959. This political isolation was amplified after the Cold War's end and the disbanding of the USSR, Cuba's main backer. In response to the political isolation, Cuba developed a highly successful hurricane warning and evacuation system, such that storms killed few people over the decades (Sims & Vogelmann 2002; Aguirre 2005). Part of Cuba's success was due to Castro's totalitarian dictatorship (Sims & Vogelmann 2002; Aguirre 2005). When the government ordered evacuations, people had to obey, efficiently moving populations out of floodplains until the storm had passed. Yet Cuba under Fidel Castro was less successful at dealing with recovery, reconstruction and longer-term hazards such as drought, partly due to its isolation (including the US trade embargo) and partly due to the country's leadership (Aguirre 2005). Concerns have also been raised that the country would not be ready for climate change's impacts (Sims & Vogelmann 2002).

For sea-level rise (see above), engineering-based approaches could make low-lying atolls inhabitable under many scenarios. These approaches are expensive to construct and maintain in isolated locations, partly due to the need for transporting all of the necessary materials and expertise long distances. Many donors have invested in the engineering of islands, such as Japan's construction of sea walls in Tonga and Maldives. So far, no one has been willing to commit the full resources necessary to guarantee century-scale inhabitation of the countries that are most expected to require population migration due to climate change.

Other mechanisms overcoming island isolation include physical connections (fixed links of bridges, tunnels and causeways), transportation connections incorporating ferries and aeroplanes and communication connections, mainly involving the internet and phones. These mechanisms assist in dealing with environmental hazards and hazard drivers, but can also lead to dependency. If an assumption is made that a mobile phone and a bridge could be relied on for requesting and bringing in disaster aid, then the maintenance of local caches and local skills could be neglected. An environmental hazard might then render the phone networks or bridge unusable, causing response problems.

This situation is a concern in the Pacific, where many islanders prefer imported, cheap, unhealthy foods, leading to reduced interest in and acquisition of local foods, thus increasing disaster vulnerability (Campbell 2009). The expectation of post-disaster assistance has also diminished some local Pacific populations' capabilities for dealing with environmental hazards (Lewis 2009). In Fiji, more isolated communities that have previously received less aid than less isolated communities have developed more local capabilities for dealing with cyclones (Johnston 2015).

Nonetheless, not all islands are isolated, insular or marginalized. Island diasporas can be important connectors (see above), or they might reinforce island isolation and marginalization. For Cuba, parts of the diaspora, especially in Florida, became vociferously opposed to Fidel Castro, deliberately seeking to increase Cuba's isolation in order to bring down his government (García 1996).

Islands can also be more connected than they seem, particularly when dealing with environmental hazards. When Montserrat's volcano first started erupting in 1995, it was seen by the UK government as a minor crisis in a faraway, small, irrelevant place. The inept governance of the crisis, especially by the UK's government, contributed to a major political scandal followed by an overhaul of how the UK Overseas Territories are governed (Pattullo 2000). Political connectedness meant that the events in Montserrat had major ramifications for London. When Eyjafjallajökull volcano in Iceland erupted in 2010, sending volcanic ash across Europe and stopping tens of thousands of commercial flights for several days, the implications of the eruption and the ensuing crisis management were felt worldwide (Alexander 2013).

Island connectedness and separateness have many levels. At times, stereotypes exist in reality, influencing the dealing with environmental hazards and hazard drivers. Many exceptions exist as well, affecting plans based on assumptions regarding island connectedness.

WHAT ARE THE GENERAL LESSONS AND FUTURE DIRECTIONS?

This paper has provided a critiquing overview of how island communities deal with environmental hazards and hazard drivers, including climate change. It emphasizes human action in causing disasters and, through DRR including CCA, addressing disasters. Many concepts and techniques in this field have emerged from island studies. Island communities demonstrate positive examples and examples with lessons for improvement, many of which are transferable to non-island contexts. The material, discussion and island lessons do not preclude the wealth of literature on this topic emerging from non-island locations, from which island studies and island locations have adopted many important ideas and actions.

More comparative analysis between island and non-island locations would assist in indicating why tailoring is needed, how to make it more effective and how to carry on exchanging between island and non-island situations. Island studies as a field continues to interrogate its own meaning (e.g. Baldacchino 2008), exploring definitions, forms and characterizations of islands while querying whether or not islands, islanders and island communities truly display fundamental and important differences from non-island contexts. The stereotypes of island characteristics and the examples that affirm and defy the stereotypes demonstrate the advantages and disadvantages of different island settings in dealing with environmental hazards and hazard drivers.

Ensuring that this knowledge is put into practice, most importantly by islanders, can be achieved by several means (e.g. Nunn 2009; Gaillard 2012; McNamara 2013; Nunn *et al.* 2016), thereby answering the question in this paper's title and achieving this paper's objective:

1. Technical and non-technical approaches need to be combined while being locally and culturally appropriate. Too often, potentially successful actions are undermined by being imposed externally without considering or engaging with local contexts.
2. Knowledge forms within and outside of the community need to be combined (Cronin *et al.* 2004a, 2004b; Leon *et al.* 2015) rather than relying on only one group's understandings.
3. Community ownership of the processes is needed from the beginning and throughout the activities (see also Cronin *et al.* 2004a, 2004b), while incorporating the critique that no community is homogenous. Groups that are marginalized within their own communities need to be included as part of successful community ownership.
4. Activities need to be connected to daily needs and interests through livelihoods. Focusing on climate change only as part of averting a difficult, distant future, or focusing on DRR for rare hazards, might not seem to be relevant to communities struggling with day-to-day needs (e.g. Gaillard (2012) for Kiribati).
5. Vested interests are not necessarily seeking success in DRR including CCA because they gain from the status quo of vulnerability (e.g. Lewis (2009) for Martinique).

These five points concatenate into the participatory development truism (Cooke & Kothari 2001) that policies and actions need to balance internal and external contributions while ensuring that interventions are accepted and expected by those who are most affected by them, in this case islanders. Often, islanders must take the initiative to lead these endeavours, as with local groups leading the work by Leon *et al.* (2015). At other times, as with Cronin *et al.* (2004a, 2004b) and Maceda *et al.* (2009), external parties invited by the communities serve as catalysts and facilitators.

These examples help to overcome the stereotype that island populations are too small, isolated and marginalized to help themselves, leading to the belief that external action must be foisted upon them. In particular, environmental hazards and hazard drivers have always been part of island life and livelihoods, with there having been plenty of successes in avoiding adverse consequences from them (Gaillard *et al.* 2008; Hung *et al.* 2011). Nonetheless, disasters continue to exact a heavy toll on island communities. Many hazards are now entering regimes that are different to those under which traditional knowledge developed, due to hazard drivers such as climate change and land-use modification. Meanwhile, internal and external causes of vulnerability are increasing, as are the options and opportunities for tackling those causes through DRR including CCA.

Any such action for and by island communities needs to identify and overcome island disadvantages without interfering with island advantages. For example, aid remains a large component of many island economies, which is a disadvantage, but no guarantee exists that aid will be forthcoming or accepted at similar rates in the future. To help themselves, island community advantages include their experiences and their diasporas. Diasporas can spread an island's experience, knowledge and wisdom regarding dealing with environmental hazards and hazard drivers, including climate change, offering them to the world in exchange for assistance being requested by island communities on their own terms. Rather than one-way aid delivery, DRR including CCA for island communities could be a mutually beneficial exchange, so that everyone gains and learns how to help themselves in dealing with environmental hazards and hazard drivers.

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